

PROFESSOR FLEEMING JENKIN, 1833-1885
PIONEER IN ENGINEERING AND
POLITICAL ECONOMY

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I

HENRY CHARLES FLEEMING JENKIN (Fleeming pronounced Flemming) was one of the intellectual giants of the Victorian period who made important contributions in several fields. Trained as an engineer, he wrote on engineering subjects and was appointed to the Chair in Engineering at University College, London, at the age of thirty-three. He was also a competent electrical engineer and he wrote distinguished articles on electrical engineering. He was, moreover, an inventor. His best-known invention was his system of *telpherage*. His literary and scientific papers were numerous, and these were published in 1887 in two volumes, pre-faced by a memoir by Robert Louis Stevenson. In the second volume appeared Fleeming Jenkin's pioneering work as an economic theorist and a study of this indicates that he anticipated Alfred Marshall on several points. Before examining his interesting papers on economics, a brief review of his life and career will demonstrate the range of this remarkable figure.

Fleeming Jenkin was born in Kent on 25 March 1833. His father was a commander in the British Navy and his mother achieved some success as a novelist. He went first to Dr. Burnett's school in Jedburgh and later to the Edinburgh Academy. In 1846 his parents were forced by reduced economic circumstances to live on the Continent. He continued his schooling there, learnt French, and showed a taste for mathematics. The Revolution of 1848 drove the family from France to Italy. Here, again, they were in the midst of a rising at Genoa, but they stayed in that city and Fleeming Jenkin attended the university as the first Protestant student.

Robert Louis Stevenson says in his memoir that the young man was fortunate in his choice of university. 'The physical laboratory was the best mounted in Italy. Bancalari, the professor of Natural Philosophy, was famous in his day; by what seems an odd coincidence, he went deeply into electro-magnetism and it was principally in that subject that Signor Flaminio, questioned in Latin and answering in Italian, passed his Master of Arts degree with first-class honours.' He completed his

degree in 1850 and started his engineering career in a locomotive shop in Genoa under Philip Taylor of Marseilles. In 1851, however, his family returned to England and to Manchester, where he became an apprentice in Fairbairn's works. He made many friends in and around Manchester (he was a frequent visitor at Mrs. Gaskell's house) and, in spite of continuing poverty and Manchester weather, he was happy.

His first employment after finishing his apprenticeship was to help with a survey for the Lukmanier railway in Switzerland. He returned to England in 1855 and was engaged as a draughtsman in Penn's marine engineering works at Greenwich. Shortly afterwards he transferred to the service of Messrs. Liddell & Gordon, a civil engineering firm engaged on railway work. This firm was associated with Newall in the manufacture of wire rope and had begun to take an interest in marine telegraphy. From 1857 Fleeming Jenkin gained experience in the employment of Messrs. Newall at Birkenhead. The firm was engaged in the manufacture of the first Atlantic cable, and he was given charge of their engineering and electrical work. He superintended machine construction in the factory, designed picking-up and paying-out machinery, fitted up steamships for electric cables, and supervised electric testing. In 1859 he made the acquaintance of Professor William Thomson and a profitable working relationship began. Thomson wrote:

In the first week of our acquaintance, the electric telegraph and particularly submarine cables and the methods, machines and instruments for laying, testing and using them, naturally formed the chief subject of our conversations and discussions; it was in fact the practical object of Jenkin's visit to me in Glasgow; but not much of the week had passed before I found him remarkably interested in science generally and full of intelligent eagerness on many particular questions of dynamics and physics. When he returned to Birkenhead, a correspondence commenced between us which continued without intermission to the last days of his life.

Fleeming Jenkin and Thomson were engaged together on many enterprises. The former worked with Thomson on important experiments on the resistance and insulation of electrical cables, and in 1861 he was the bearer of Thomson's proposal for the Committee on Electrical Standards named by the British Association. Thomson encouraged his collaborator to write, and from this period begins Jenkin's contribution to scientific journals. The eighth edition of the *Encyclopaedia Britannica* carried Jenkin's measurements for the resistance of gutta-percha given as the only absolute measurements of the kind made at that date. As Secretary to the Committee on Electrical Standards, Jenkin wrote their reports, published in 1869. In 1862 he produced, for the *Philosophical Transactions*, *Experimental Researches on the Transmission of Electrical Signals through Submarine Cables*.

In 1859 Fleeming Jenkin was elected A.I.C.E. and in the same year he was examined before the Royal Commission on the Submarine Telegraph. At the Exhibition of 1862 he was made Juror for Physical Apparatus and named Reporter for Electrical Apparatus. In 1866 he was appointed Professor at University College, London, and he gave the Cantor Lectures on the Construction, Laying and Testing of Submarine Cables. In 1868 he was appointed to the Chair of Engineering at Edinburgh University, and Stevenson says that now 'pecuniary embarrassments passed for ever out of his life'. He was elected M.I.C.E. and he gave evidence before the Select Committee on Scientific Instruction.

It was in Edinburgh that Fleeming Jenkin began his seminal work in economics. In March 1868 he contributed an article to the *North British Review* entitled 'Trade unions: how far legitimate?' This was a review of the reports of the Commissioners appointed to inquire into the organization and rules of trade unions and other associations. Two years later he contributed to *Recess Studies* (edited by Sir Alexander Grant) an article on 'The graphic representation of the laws of supply and demand and their application to labour', and he followed this with a contribution to *The Proceedings of the Royal Society of Edinburgh* (session 1871-2) entitled 'On the principles which regulate the incidence of taxes'.¹

Until 1873 Jenkin was also engaged in the laying of submarine telegraph cables. He helped with the manufacture of part of the first Atlantic cable (as we have noted) and also with the Red Sea cable, the Singapore-Batavia cable, and important Mediterranean cables, including the first Malta-Alexandria cable. He accompanied various expeditions helping to lay cables, and from 1868 he entered into an agreement with Thomson to act as joint engineers to submarine cable companies. He was also adviser to the government on submarine cables while these were being transferred to the Post Office and he was responsible for testing cables acquired. The story of his journeys may be read in the letters quoted in Stevenson's memoir, and the reader will be entertained by the sketches made by Jenkin of Latimer Clark and other shipmates.

In 1873 Jenkin wrote *Magnetism and Electricity* for Longman's Science Series. Many editions followed, and the book was translated into Italian and German. For the ninth edition of the *Encyclopaedia Britannica* he

¹ These articles, plus two unpublished manuscripts, viz. 'The time-labour system: or how to avoid the evils caused by strikes' (1879-1881) and 'Is one man's gain another man's loss?' (1884), were included in *Papers Literary, Scientific, &c.*, by Fleeming Jenkin, F.R.S., LL.D., with a memoir by R. L. Stevenson, edited by Sidney Colvin and J. A. Ewing, 1887, containing also a note on the contributions by Fleeming Jenkin to electrical and engineering science by Sir William Thomson, 2 volumes. The London School of Economics reprinted *The Graphic Representation of the Laws of Supply and Demand and other Essays on Political Economy* in 1931.

wrote an article on Bridges, afterwards published as a separate treatise in 1876. A paper 'On the application of graphic methods to the determination of the efficiency of machinery', read before the Royal Society of Edinburgh and published in the *Transactions*, 1876-8, earned for him the Keith gold medal. Thomson stated that the paper 'was a continuation of the subject treated in Relaux's Mechanism and . . . supplied the elements required to constitute from Relaux's kinematic system a full machine receiving energy and doing work'. In 1879 Jenkin was elected Vice-President of the Royal Society of Edinburgh.

In the 1870's also, Jenkin made a substantial contribution in connexion with sanitary reform. His interest developed as a result of correspondence in *The Times* on the health and sewage of towns in which he took part. In 1877, lecturing to the Philosophical Institution of Edinburgh, he proposed the establishment of a Sanitary Protection Association on the same lines as the Steam Boiler Protection Association proposed by Sir William Fairbairn. The Edinburgh Sanitary Protection Association was formed in consequence, and other societies followed in London and elsewhere, to some of which Jenkin was made consulting engineer. In 1878 Jenkin published *Healthy Houses*, the substance of lectures delivered in Edinburgh, and from 1880 to 1885 further publications on the same subject were written by him.

The last years of Jenkin's life were spent in working out a system of electrical transport called by him telpherage. This was suggested to him by Professors Ayrton's and Perry's description of the electric railway block system. In a paper read before the Society of Arts in 1884, Jenkin said that telpherage was intended to 'designate all modes of transport effected automatically with the aid of electricity'. Stevenson tells us that the invention was costly to Jenkin because it 'consumed his time, overtaxed his strength and overheated his imagination'. Be that as it may, the hopes which he cherished for its success heightened the close of his life, and Stevenson concludes: 'However Fleeming chafed among material and business difficulties, the rainbow vision never faded . . . he may be said to have died upon a pleasure.' On 12 June 1885, after a trifling operation on his foot, Jenkin's life ended. A telpher line was opened at Glynde, Sussex, in October 1885 (with Professor Perry as engineer for the Telpherage Company) and two other lines were erected in Weston.

The notice of Fleeming Jenkin in the *Dictionary of National Biography* comments: 'In practical engineering, thoroughness and soundness marked all Jenkin's work. His determinative work in electricity is of the highest value, while his varied originality as an inventor is testified by his 35 British patents and by his scientific papers.' His work as an economist

has not received much notice¹ but, as will be shown, this, too, was noteworthy.

II

In Palgrave's *Dictionary* Edgeworth wrote that Jenkin had '... contributed to political economy some very original papers of the highest theoretical importance and of considerable practical interest'.² Much later Schumpeter claimed Jenkin to be '... an economist of major importance, whose main papers ... form an obvious stepping stone between J. S. Mill and Marshall'.³ With such credentials from high authority it is surprising that, as far as we are aware, no complete account and assessment of Jenkin's contributions to economics has appeared. We hope that the present article will go some way towards filling this gap.

Being a mathematician it was natural for Jenkin to think that economic relations could be '... stated as accurately, and defined in the same manner, as any mathematical laws affecting quantities of any description' (p. 76).⁴ His applications of the mathematical method to economics are all related to the partial equilibrium analysis of individual markets which has since become Marshall's trade-mark. Jenkin first analyses 'what determines the price of a given commodity at a given time in a given market ...' (p. 76) by means of the following model (pp. 17-18, n. 1):

$$(1) D = f(A + 1/x),$$

$$(2) S = F(B + x),$$

$$(3) D = S,$$

where D is the quantity of a particular commodity demanded, S the quantity supplied, x the variable price, and A and B unknown variable quantities. From equations (1) to (3) the equilibrium price is given by $f(A + 1/x) = F(B + x)$.

Although Jenkin did not rigorously examine the form of these demand and supply functions [equations (1) and (2)] he stressed that they are subjectively based. 'In a given market, on a given day, the elements of the demand and supply curves already exist in the minds of purchasers and sellers' (p. 88). And: 'Enough has now been said to show how much the value of all things depends on simple mental phenomena, and not on laws having mere quantity of materials for their subject' (p. 93).

¹ But see the account of him in Palgrave's *Dictionary of Political Economy*. Marget, Schumpeter, and Whittaker are three writers who have paid attention in recent years to this neglected economist.

² Op. cit., vol. ii, p. 473.

³ *History of Economic Analysis*, p. 837, n. 10.

⁴ The references in brackets after quotations are to vol. ii of Jenkin's collected papers; see p. 206, n. 1.

With respect to demand: 'The value which buyers and sellers set on any article depends on different motives. The demand in the buyer's minds corresponds to the utility which, in their opinion, attaches to the article' (p. 98). Since equation (1) represents an inverse relation between demand and price some notion of diminishing marginal utility would seem to be implied. With respect to market supply, as the total available quantity is fixed, the basis of equation (2) cannot be found in the conditions of production. In making the statement '... price of all ... limited commodities depends on a conflict between the desire for the commodity and the reluctance to sell it' (p. 21), Jenkin appears to have been thinking of the possibility of producers' consumption, particularly as wheat is one of the main examples used (pp. 77-84). But this basis for the form of equation (2) cannot apply to manufacturers because they 'rarely desire the article they make for itself, but make it only with the object of selling it' (p. 88). Short-run supply should, in this case, be constant regardless of price. Jenkin, however, invokes expectations to support a direct relation between supply and price. 'There are always a few holders who would only sell if the price were much higher than the market price,—these are the people who expect price to rise; there are some who are just willing to sell at the market price, but who will not sell a penny below; and there are others, weak holders, who expect prices to fall, and these would really, if pushed to extremity, sell below the market price' (p. 109).

Equation (3) is an equilibrium condition reached by the operation of market forces. 'If x were to rise by what we may term an accident for a day or two above the value determined by the equation [i.e. $f(A + 1/x) = F(B + x)$] ... the quantity supplied would be in excess of that required, competition would therefore at once lower the price to its true value as determined by the equation' (p. 17, n. 1). In other places Jenkin fully discusses the various market reactions of buyers and sellers that maintain price at the equilibrium level where supply equals demand (e.g. pp. 78 and 123). This discussion is very similar to that currently used in textbooks.

In representing the analysis graphically, Jenkin follows the mathematical convention of locating the dependent variable on the vertical axis; the reverse, of course, of the convention initiated by Marshall. In Fig. 1 D is the demand curve, S the supply curve, and Ox the equilibrium price. Although Jenkin does not consider stability conditions, the demand and supply curves are so drawn that the equilibrium price given by the intersection of the two curves is stable. Shifts in these curves would be caused by: changes in the total fixed supply; changes in men's minds, including their expectations; and changes in buyers' income—'The funds available for purchase at any price are limited, and this,

which may be called the purchase fund, limits the possible demand' (p. 79). Jenkin uses a series of graphs (pp. 80-83) to examine the effect on equilibrium of various plausible shifts in the curves; for example, the effect of an increase in income is shown by a shift of the demand curve to D_1 .

The foregoing analysis relates to a very short period. 'In the long run, the price of the manufactured article is chiefly determined by the cost of its production, and the quantity manufactured is chiefly determined by the demand at that price' (p. 89). Thus, buyers' 'opinion of the utility of the article does not ultimately affect the price' (p. 99). It

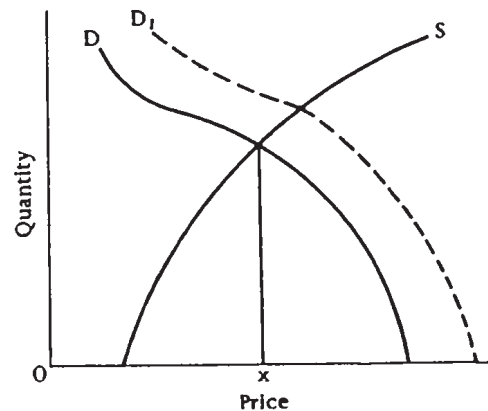


FIG. 1

is producers' reactions that equate price and cost because, if there is insufficient demand 'at cost price (including what they think a fair profit), they will cease to produce, or produce only as much as the demand at that price requires. While, if the demand equals or exceeds the supply at a higher price than cost price as above defined, makers will be tempted to produce more' (pp. 88-89), and 'new makers will produce, and by their competition soon reduce cost to that which represents an ordinary profit on outlay' (p. 24). Jenkin drew long-run demand and supply curves similar in shape to those in the above diagram, with particularly steep supply curves. The form of the supply function is now based on production conditions, decreasing returns being the typical case: '... the cost of production will gradually increase with the quantity produced, owing to the limitation of labour, of capital and of raw material' (p. 91) and: 'The cost of production varies with the quantity to be produced, because as more is wanted a higher price is generally required to tempt more capital and labour into the given walk [industry]' (p. 92). This account of cost conditions would appear to contradict Jenkin's statement that value is unrelated to utility. It is, however, recognized that 'Only

in the case in which the supply curve is a vertical line at one price [i.e. constant costs] is it strictly true that the cost of production determines price without reference to demand; but for all those cases in which the cost of production varies little with the quantity produced, the statement is approximately true' (p. 92).

It should now be clear that Jenkin anticipated, in print at least, Marshall's synthesis of the ideas of Jevons and others about demand with those of Ricardo and Mill about cost of production and supply. There is, for example, little in Marshall's celebrated scissors analogy that is not represented in Jenkin's diagrams. Jenkin, moreover, was the first Englishman to discuss demand functions and he introduced the diagrammatic method into English economic literature. Although diagrams had been used earlier by such continental writers as Cournot, Dupuit, and von Mangoldt, his use of them was more thoroughgoing and basic to the analysis. Furthermore, Jenkin was evidently unaware of Dupuit's work (see p. 110) and so was probably unacquainted also with other continental writers. His value theory was thus possibly a rediscovery.

Jenkin developed his analytical apparatus for two main purposes: to examine the relation between trade unions and wage determination and to elucidate the effects of commodity taxation. He wrote at a time when there was considerable public criticism of the activities of trade unions. They were charged, *inter alia*, with: injuring the quality of products by reducing competition among workmen; discouraging piecework and overtime; opposing the use of machinery; and using force and criminal tactics. Jenkin suggested that the 'one argument in favour of permitting combinations of workmen to bargain with their employers is that these combinations do enable men to make a more advantageous bargain with the capitalist' (p. 7). To support this view he explored wage theory, starting with a consideration of the then current wages-fund doctrine. Mill had stated the doctrine thus: 'Wages depend . . . on the proportion between the number of the labouring population and the capital or other funds devoted to the purchase of labour' (p. 8). Jenkin recognised this to be a mere truism. 'Very clear and very true. When you know the number of recipients and the sum to be paid them, divide the number of shillings by the number of men, and you obtain the mean wages. . . . Diminish the number of men, diminish your divisor, says Mill, and your quotient will be larger' (p. 8). Jenkin also disagreed with the argument that changes in the wages fund depended only upon the profits of capital since it 'may increase by obtaining a larger share of the gross receipts from the sale of produce, though profits may be less; it may be swelled by the increased savings of the community made in the face of a diminished average rate of interest; it may rise by an increase in the gross receipts

received by the maker from the consumer' (pp. 13-14). Thus: 'A manufacturer will generally work his mill or factory to the utmost so long as he does obtain a profit; he does not voluntarily set aside a certain sum for wages, diminishing and increasing that sum according to profits, but he employs as many men as he can, and pays them what he must' (p. 10). Jenkin's disagreement with Mill's hypothesis that saving varies directly with interest is based on the idea that '. . . if men can get 10 p.c. for their money they will consider they have made sufficient provision for their family by investing 10,000 l.; if they can get only 5 p.c. they feel compelled to provide 20,000 l. before retiring from business' (p. 11). Criticism of the wage-fund theory by Jenkin (1868), Longe (1867), Thornton (1867), and Leslie (1868) led Mill to make his famous recantation in 1869.

Jenkin thought that, in the short run, wages, like the price of all other limited commodities, depended upon market supplies and demand, with the important reservation that they may be affected by bargaining between employer and employee (pp. 19-26). He also applied his long-run analysis: 'The cost of production of his labour may be defined as the cost of maintaining the labourer from his birth to his death; . . . labourers do not produce and keep a family until their wages equal the cost of maintenance, including such enjoyment of comfort as in their opinion make life tolerable. . . . The labourer if dissatisfied with his comforts, does not cumber himself with a wife and family—he even emigrates, or, in the last resort goes on the parish, and dies' (pp. 99-100). '. . . If we begin by raising the standard of comfort which our labourer desires, we shall both limit the population and raise wages. The limitation of population is the intermediate machinery by which the desired end is to be effected, but the motive power must be sought in individual self-interest or discontent' (p. 102). 'The trade union, therefore, has a permanent action in raising wages, because it enables men to accumulate a common fund, with which they can sustain their resolution not to work unless they obtain such pay as will give increased comfort' (p. 104). But, while 'It is the seller of labour who determines the price, . . . it is the buyer who determines the number of transactions' (p. 105); thus unemployment could result from pressure to increase wages.

After recognizing that higher wages may alter the distribution of income Jenkin wrote: 'Looking at the relative position of the rich and poor, we do not think that the permission to combine should be withheld because it tends to diminish the present inequality of condition. Great inequality is necessary and desirable (. . . observation seems to show that trade will extend faster with large profits and small wages than with small profits and large wages) but it is at present great enough to admit of some

reduction' (pp. 31-32). In any case, the total abolition of trade unions was 'out of the question as impolitic, undeserved, and impossible . . .'; consequently, ' . . . in the interest of society and in protection of the rights of the minority . . . we must insist that the great power granted to the bodies of workmen shall be administered under stringent regulations' (p. 67). Jenkin proceeds to examine alleged abuses and makes many practical proposals (pp. 35-75) about which Edgeworth stated: 'much weight attaches to his advice as to the rights and limitations of combination'.¹

A further improvement of the labour market suggested by Jenkin was the introduction of a time-labour system of engagement to replace the personal system. 'Each engagement ought not to be a contract with a man to keep him individually for a whole year or other period, but should provide on the one hand that the master shall employ one competent hand for the given time at the given rate, and on the other hand that the workman shall not leave without providing a competent substitute who will work until the end of the given time at the given rate' (p. 134). He did not, however, entertain much hope for its acceptance: 'Neither party would, by adopting the time-labour system, gain the smallest advantage over the other; a fact which may, for some time, prevent it from finding an advocate' (p. 138).

The theory of wages, particularly in regard to the influence of trade unions, was greatly improved by Jenkin. Schumpeter, indeed, claims that he must 'be added to the list of the builders of modern wage theory'² and goes so far as to suggest that his making explicit and actually drawing a labour demand curve 'implies an embryonic marginal productivity theory'.³

The second use Jenkin found for his analytical apparatus was to investigate the incidence of commodity taxes. First: 'The graphic method may . . . be employed to indicate the advantage gained by each party in trade, and to show how it may be estimated in money' (p. 108). In Fig. 2 DN and SR are demand and supply curves.

'Looking at the demand curve, the ordinate x_A from the axis OY to A represents the value set on some of the goods by some buyers, but these buyers have got the goods for the sum represented by the ordinate $x = OM''$; the difference between these two ordinates $x_A - x$ is the difference in price between what was given and what might have been given for a certain small quantity Δy of goods. $\Delta y(x_A - x)$ is, therefore, the benefit reaped by buyers from the purchase of the quantity Δy ; and integrating the benefits derived from the sale of each successive quantity, we find the area $M''PN$ represents the whole gain to buyers by the purchase of

¹ Palgrave, vol. ii, p. 473.

² *History of Economic Analysis*, p. 942.

³ *Op. cit.*, p. 664.

the quantity OQ of goods. Similarly, it is easy to show that the area $M'PR$ represents the gain to sellers by the same transaction; these areas represent the gain in money, each product $\Delta y(x_A - x)$ being the product of a quantity by the gain in money per unit of quantity. Thus the whole benefit to the two leading communities is represented by the sum of the two above named areas, and the partition of the benefit between the two communities is perfectly definite' (p. 109). Since the curves 'for given

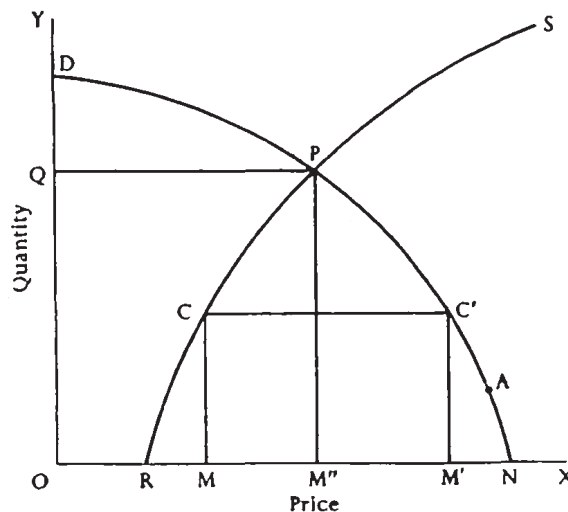


FIG. 2

goods might be determined experimentally by observing from year to year variations of quantities bought or quantities supplied at various prices' (pp. 107-8) it might be possible to give 'a numerical estimate in money of the value of any given trade . . .' (p. 110). Jenkin then demonstrates that the relative values of the two surpluses depend upon the steepness of the demand and supply curves.

He next considers 'the incidence of a tax on trade, levied as a fixed sum per unit of goods. . . . The effect of such a tax is to produce a constant difference between the price paid by the buyer and the price received by the seller. The market prices are determined in the diagram . . . by the points between which a line parallel to OX , and equal in length to the tax, can be fitted between the two curves' (pp. 112-13). Thus if ' CC' ' be the amount of the tax per unit of goods, then OM is the market price to the supplier, OM' the market price to the buyer, and the difference MM' is equal to the tax' (p. 113). From this construction Jenkin calculates the relative losses of producers' and consumers' surplus and points out both that each party's loss is greater than the tax paid and that these losses increase with the rate of tax.

Jenkin had rediscovered (see p. 110) not only the theory of consumers'

surplus that Dupuit had propounded but also the approximation Dupuit used to apply it. He was, furthermore, the first both to publish an account of producers' surplus and to develop and apply to problems of taxation the full surplus analysis.

Economists have always found the temptation to comment on the welfare implications of free markets difficult to resist. Jenkin was no exception. He tended to take a favourable view of market mechanisms: 'Whatever school of religion or philosophy we belong to, we cannot deny that each man, acting rationally for his own advantage, will conduce to the good of all; and if the motive be not the highest, it is one which at least can always be counted on' (p. 105). And: 'In a rapidly advancing community those who make improvements may become rapidly rich relatively to those who make none, but they nevertheless benefit the stationary class. Their own benefit is wholly derived from their own products and from the productions of those who, like themselves, make improvements' (pp. 147-8). He did, however, have some reservations about the labour market: 'They [labourers] think it monstrous that one of two parties to a bargain should be told to shut his eyes and open his hands and take the wages fixed by Political Economy, which allegorical personage looks very like an employer on pay day' (p. 26).

Although we may claim for Jenkin objective priority on a number of aspects of economic analysis, his work appears to have had little influence on the development of economic thought. Whittaker¹ suggests that this may be because he was not a professional economist and because the two writers he is most likely to have influenced, Jevons and Marshall, treated him shabbily, to say the least.

Contact between Jevons and Jenkin is disclosed by H. Stanley Jevons who wrote, in the preface to the fourth edition of *The Theory of Political Economy*,² that in one of his father's manuscript notes there is mention of correspondence with Jenkin about mathematical economics. It appears, moreover, that the publication of Jevons' *Theory* might have been delayed if it were not for the appearance of Jenkin's essays. Jevons, in commenting on 'The graphic representation of the laws of supply and demand', says: 'The essay is ingenious and instructive, and probably correct at almost all points; but I may add that from about the year 1863 I regularly employed intersecting curves to illustrate the determination of the market price in my lectures at Owens College.'³ There is evidence that a 'book of careful lecture notes taken down by a member of his class . . . do, indeed, include a sketch of a demand curve'.⁴ But,

¹ *A History of Economic Ideas*, pp. 452-3.

² p. lvii.

³ *Ibid.*, p. 333.

⁴ J. M. Keynes, 'William Stanley Jevons', *Journal of the Royal Statistical Society*, 1936, p. 539.

clearly, either Jevons was exaggerating or this particular student of his did not have a very strong appetite for graphs.

If Jevons's reference to Jenkin was uncharitable, Marshall's was inadequate. The only acknowledgement is inappropriately located in Book V and appears at the end of a long footnote. This concerns consumers' surplus and reads: 'The graphic method has been applied, in a manner somewhat similar to that adopted in the present chapter, by Dupuit in 1844; and independently by Fleeming Jenkin (*Edinburgh Philosophical Transactions*) in 1871.'¹ Although as early as 1872 Marshall was acquainted with Jenkin's work² he denied any relation between his own analysis and that of Jenkin in a letter to Seligman dated 6 April 1896: '... my obligations are solely to Cournot; not to Fleeming Jenkin or Dupuit. I had given the main substance of my doctrines in lectures a year or two before he read his paper at Edinburgh. ...'³ Keynes substantiates this in his memoir of Marshall. 'The evidence as to the order of his studies is as follows: In 1867 he began with the development of diagrammatic methods. ... By 1871 his progress along these lines was considerably advanced. He was expounding the new ideas to pupils and the foundations of his diagrammatic economics had been truly laid.'⁴

If the above testimony is accepted, then the influence of Jenkin on the development of economic doctrine may be regarded as slight. His personal achievement, however, is remarkable. He was not a trained economist, appears to have read little other than J. S. Mill, and his main economic papers were spread over a period of only four years. Yet the clarity and originality of his economic theorizing were of the highest order.

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¹ *Principles of Economics* (8th ed.), p. 476.

² See Marshall's review of Jevons' *Theory* in *Academy*, 1 Apr. 1872.

³ J. Dorfman, 'The Seligman correspondence III', *Political Science Quarterly*, 1941, p. 407.

⁴ 'Alfred Marshall 1842-1924', *Economic Journal*, 1924, p. 330.